Performance and benefits of Bus Rapid Transit

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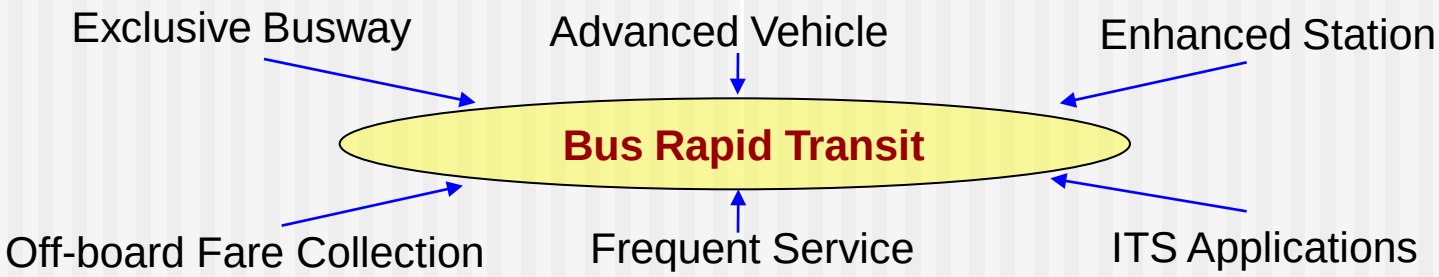
Overview

- Concepts and components of BRT
- BRT within the mobility offer
- Evolution of BRT systems – global diffusion
- Evaluation:
  - Passenger feedback
  - Technical performance
  - Costs, externalities and impacts on land development
- Conclusions

Concept and components of BRT

Definition

"Rapid mode of transportation that can combine the quality of rail transit and the flexibility of buses". --- Federal Transit Administration (FTA)



Concept and components of BRT

Busway

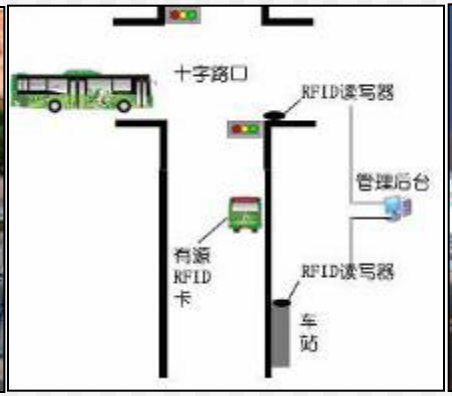
Advanced Vehicles

Enhanced Stations

Fare collection

Frequent service

ITS Applications



System identity

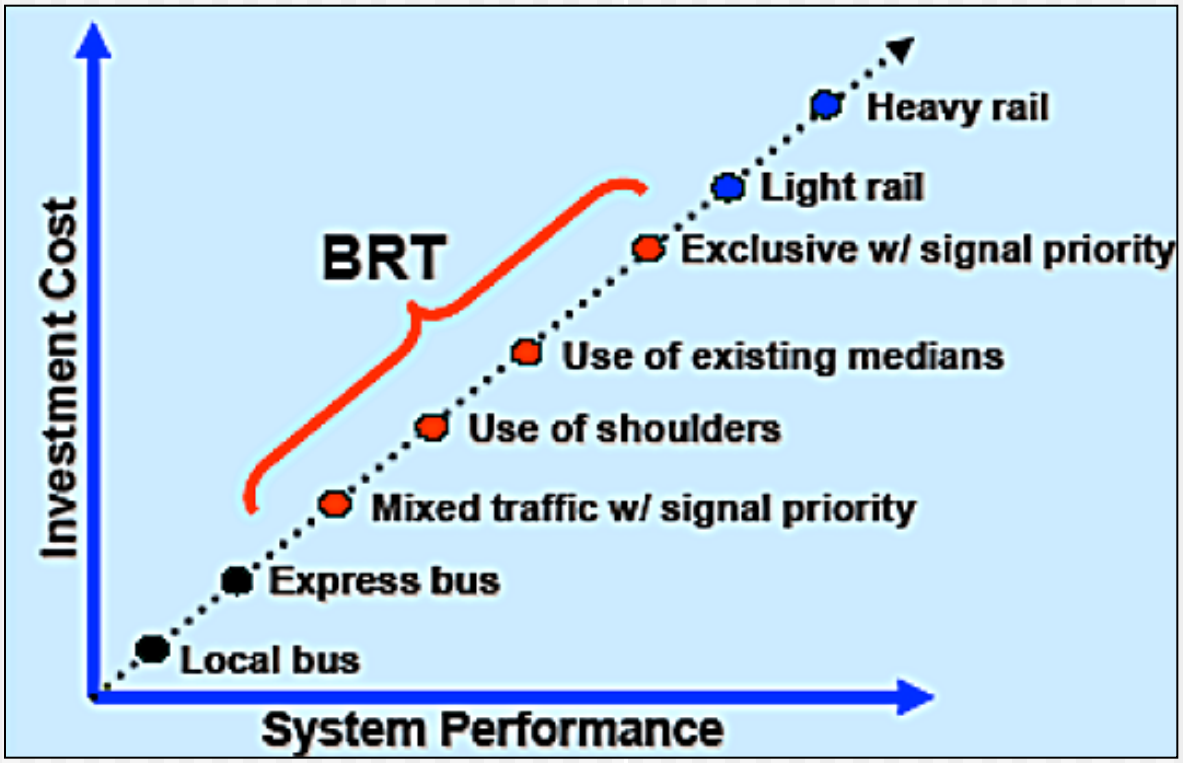
Definitions of BRT

BRT Definitions	**Source**
BRT is "a rapid mode of transportation that can combine the quality of rail transit and the flexibility of buses".	Thomas, 2001
BRT is "a flexible, rubber-tired form of rapid transit that combines stations, vehicles, services, running ways, and ITS elements into an integrated system with a strong image and identity".	Levinson et al., 2003, p.12
BRT is "a rubber-tired rapid transit service that combines stations, vehicles, running ways, a flexible operating plan, and technology into a high quality, customer focused service that is frequent, fast, reliable, comfortable and cost efficient".	McCormick Rankin Corporation, 2004, p.16

Main components of a BRT system

Components	Levinson et al., 2003	Canadian Urban Transit Association, 2004
Running ways	BRT vehicles operate primarily in exclusive transit-ways or dedicated bus lanes. Vehicles may also operate in general traffic.	Three types of busways, including exclusive busways, dedicated lanes and mixed traffic.
Stations	BRT stations, ranging from enhanced shelters to large transit centres.	Sufficient shelter from inclement weather, seating, customer information, appropriate lighting and ample platform space for boarding, alighting and waiting are the minimum requirements.
Vehicles	Quiet, high-capacity vehicles use clean fuels to protect the environment.	The ideal BRT vehicle has a level of passenger comfort, is visually attractive, and is environmentally friendly.
Services	High-frequency service. The integration of local and express service can reduce long-distance travel times.	A variety of service alternatives, including all stops route(s), limited stop service, feeder services.
Route Structure	BRT uses simple, often colour-coded routes.	
Fare Collection	Pre-boarding fare collection. They allow multiple door boarding, reducing time in stations.	Multi-door boarding for customers with pre-paid fare media.
ITS	Applications of ITS technologies include automatic vehicle locationing (AVL) systems, passenger information systems, and traffic signal preference at intersections.	A collection of computer and communications technologies that can enhance the convenience, safety and reliability of a BRT service.

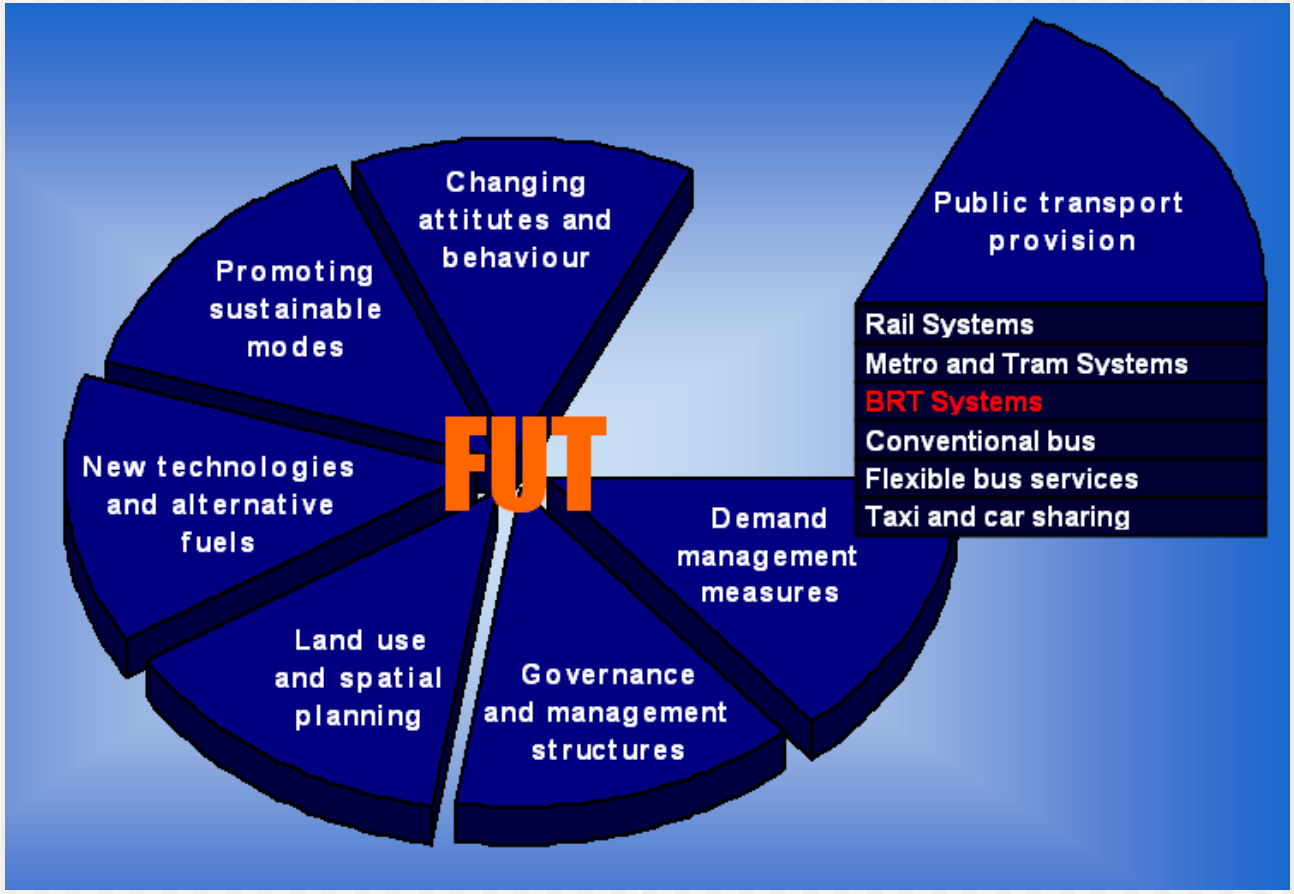
The spectrum of different BRT applications



Source: Tindale Oliver & Associates, Inc; Cited by Cain et al., 2009, pp.3

Note: It has been argued that BRT can match or even surpass the performance of LRT in some circumstances, but this is not reflected in the Figure.

“Future Urban Transport” (after VREF)



Motivation to introduce BRT

Is there an alternative to these conditions?

Motivation to introduce BRT

- Widening roadways
- Building flyovers
- Expanding highway network

} A temporary relief

- Growth rate of vehicles is much faster than that of the road network.
- These means alone are not capable of solving the complicated congestion problems.

Limitations of rail-based transit

High investment costs

High operating costs

Long construction period

- Rail-based transit is recognized as a good solution to the growing traffic congestion problem, but the construction investment and operating deficits have caused an enormous debt burden on the city.
- Cost-effectiveness??? Affordability???

✓ Bus Rapid Transit (BRT) is considered as a lower cost rapid transit *solution*.

Evolution of the BRT concept (Deng and Nelson, 2011)

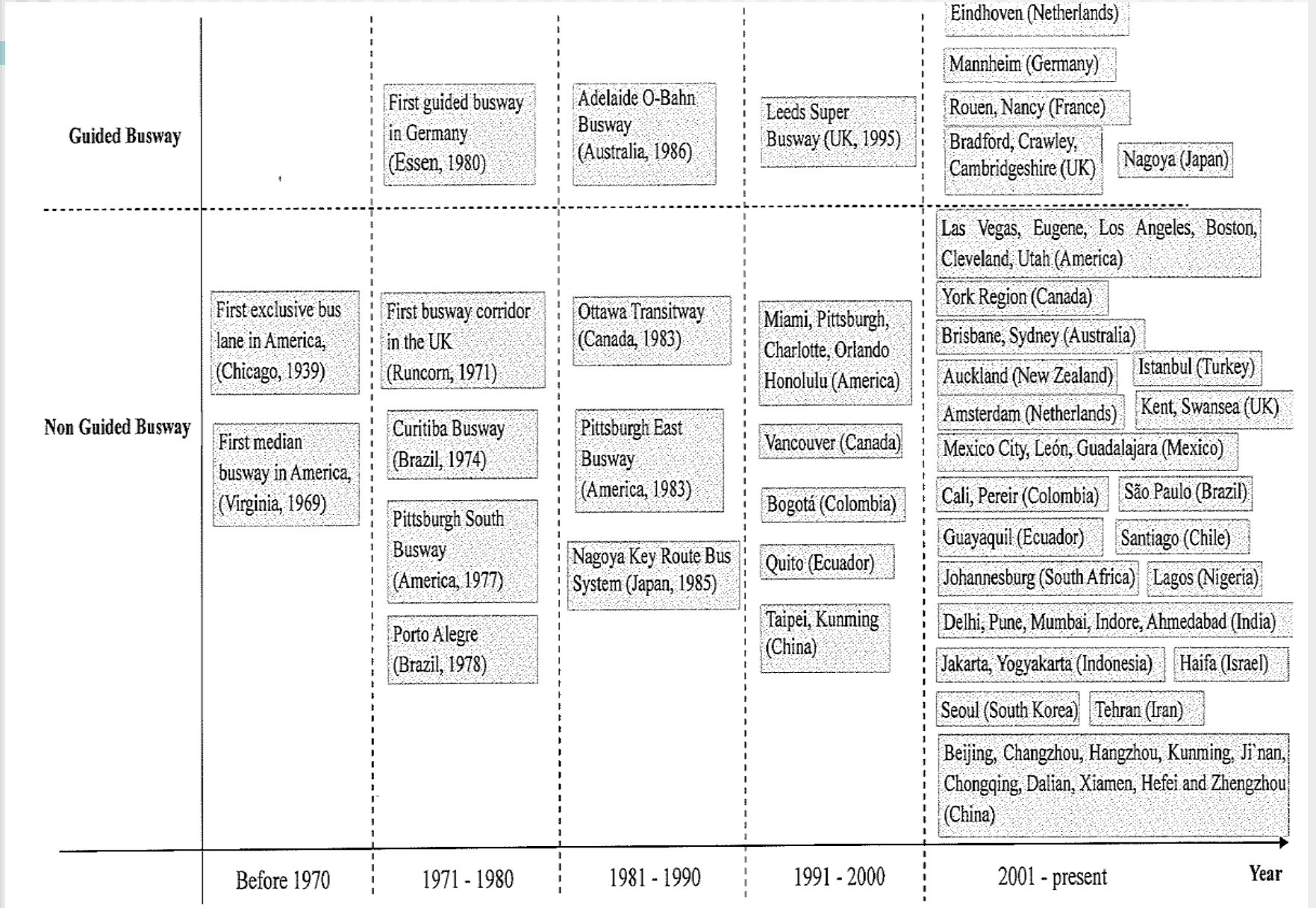


Figure 2: The global diffusion of BRT systems

Application of BRT across the Globe

- 40 years of experience
- From Latin America to North America, Oceania, Europe and Asia
- Handout: Overview of selected BRT schemes
  - System overview
  - System performance
  - Key reference

Examples of BRT

Bogotá (Colombia)

Changzhou (China)

Brisbane (Australia)

Quito (Ecuador)

Source: Karl Fjellstrom, ITDP

Beijing Southern Axis BRT line 1

Exclusive busway

Advanced vehicle

Enhanced Station

Bus Rapid Transit

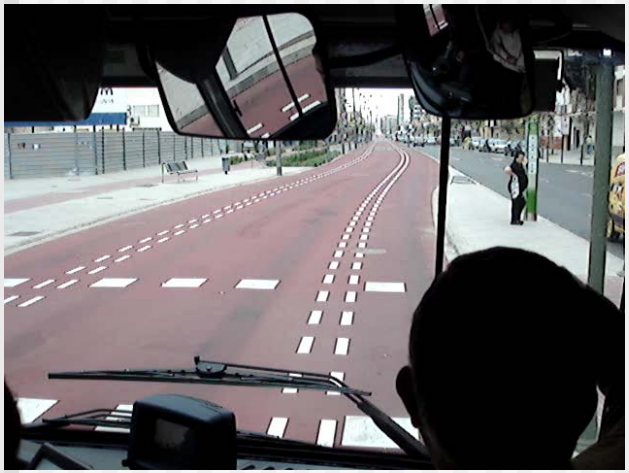
Pre-board fare collection

Frequent service

ITS Applications

BRT in Europe

Nantes (dual carriageways used to introduce BRT)



Castellon (Optical Guidance)

Swansea (city centre bus priority network)

Buses with a high level of service (BHLS) - http://www.bhls.eu/

Photos: Brian Masson

What the passengers think

Evaluation of the BRT service in Beijing (Deng and Nelson, 2010)

- Seven attributes, including speed, reliability, safety, convenience, frequency, comfort & cleanliness and overall service quality, were measured.

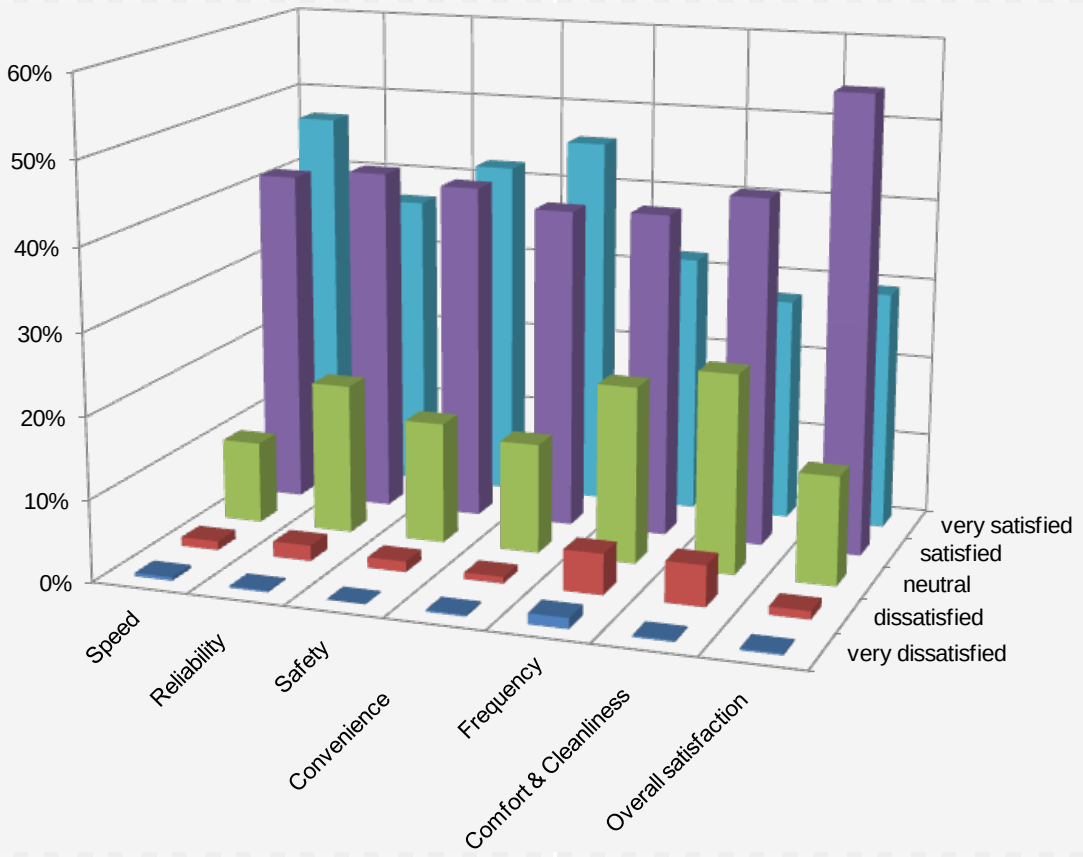
  --- respondents have strong positive opinions on the BRT service.
  --- 85.5% of passengers rated overall satisfaction of BRT service as “very satisfied” or “satisfied”.
  --- in particular, respondents thought BRT was fast and convenient.

- Choice users have a higher expectation on BRT than captive users in terms of reliability, comfort & cleanliness and overall satisfaction

- Suggestions for improvement:

  - Address overcrowding problem
  - Vehicle interior: not always kept clean
  - Shelter: does not provide passengers effective protection from the bad weather.

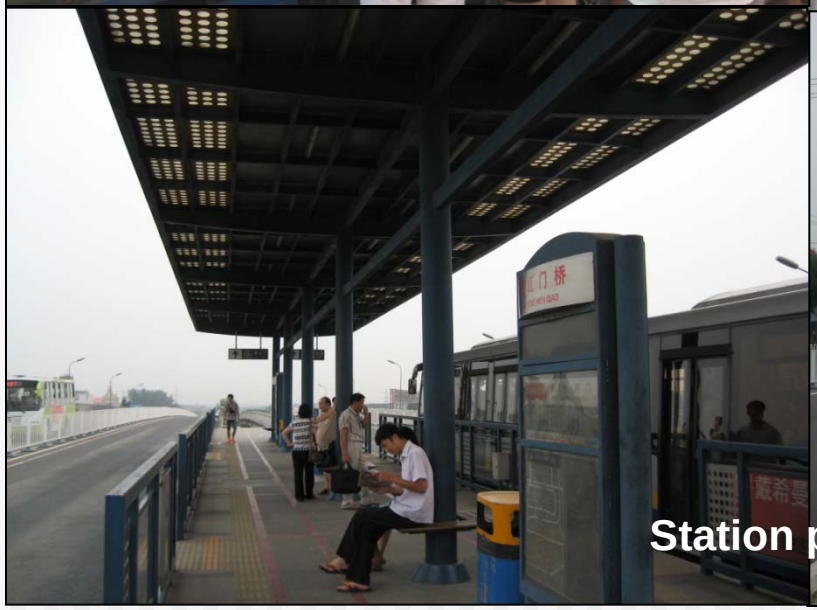
Satisfaction with the BRT service in Beijing (N=525)



Travel-related characteristics: some problems (Beijing)

Crowding problem

Vehicle interior



Station problem

How does BRT compare with other Mass Transit Systems?

(*Sources:* Vuchic (2005); Zhang (2009); International Energy Agency (IEA) (2002)

Transport Mode	Bus Rapid Transit	Light Rail Transit	Metro
Right-of-way Requirements	Mainly shared right-of-Way (at-grade) or exclusive right-of -way or arterial lanes	Exclusive right-of-way (elevated) or shared right-of-way (at-grade)	Exclusive right-of-way
Support	Roadway	Steel track	Steel track
Vehicle propulsion	Internal combustion Engine	Electric	Electric
Vehicle control	Mainly visual	Sign control	Sign control
Construction time	< 18 months	2 to 3 years	4 to 10 years
Space requirement	2-4 lanes taken from existing road	2-3 lanes taken from existing road	Little impact on existing road
Flexibility	Flexible in both implementation and Operation	Limited flexibility, somewhat risky in financial terms	Inflexible and financially risky
Direct impact on traffic flow	Depends on design/available space in roadway corridor	Depends on design/available space in roadway Corridor	Does not take space away from Roadway
Maximum Capacity (passenger/unit)	160	170 – 280	240
Minimum headway (seconds)	12 – 30	75 – 150	120 – 150
Maximum frequency (Transit units per hour)	120 – 300	24 – 48	24 – 30
Line capacity (passenger/hr)	Medium 9,000 - 30,000	Medium 12,200 - 26,900	High 67,200 - 72,000
Maximum Speed (km/hr)	60 – 70	60 – 80	70 – 100
Commercial Speed (km/hr)	15 - 25 (higher for some commuter systems)	15 – 25	30 – 40
Average Capital Cost (2000 $/mile) (millions)	$13.46	$34.70	$168.51
Average Operation Cost (2000 $ per vehicle revenue mile)	$4.73	$12.22	$8.54

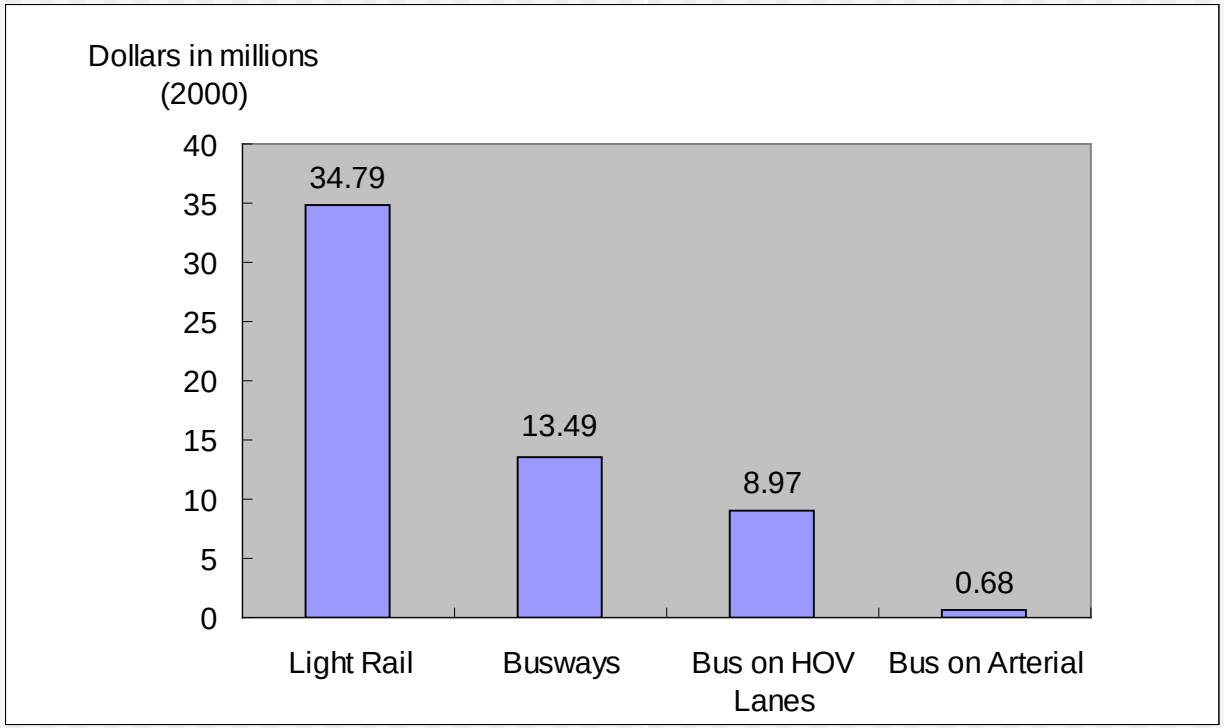
Performance issues

- Improving vehicle speed is probably the most fundamental goal
- BRT systems that operate on exclusive busway generally experience the most travel time reliability
- Most advanced BRT systems utilize fast boarding techniques
- Vehicle design is important, especially in high demand periods
- It is possible to create a high perception of BRT amongst the general public
- How “permanent” is BRT?

Cost issues and externalities of BRT

- Typically, the overall capital and operating costs for BRT systems are less than similar rail-based systems
- BRT has the ability to deliver a high-quality mass transit system but impose less burden on subsidy
- Extensive BRT systems can be built within a short period
- Evidence relating to operating cost is mixed
- As with any form of public transport there are concerns about negative impact on urban life

Capital cost per mile for LRT and BRT



Source: U.S. Government Accountability Office, 2001, p17

Note: Cost adjusted to fiscal year 2000 dollars

BRT and Land Development

- It is widely appreciated that mass transit systems may have a positive effect on the timing or probability of land development

- BRT can be implemented in phases and this provides a good opportunity to show early progress with small capital investment

- Flexibility of service is an advantage and a weakness; issues of permanence

- It can be argued that financing and risk assessment are the main factors affecting “Transit Oriented Development” (TOD) policy rather than rail versus bus

- Growing body of evidence that BRT systems have a positive development on land value uplift

Impact on Land Development of Selected Bus Rapid Transit Systems

Authors	City	BRT system	Land Development Impact
Rabinovitch and Hoehn (1995)	Curitiba	Surface Metro	High density residential and commercial development occurred along BRT corridors.
Rodríguez and Targa (2004)	Bogotá	TransMilenio	After only 2-years of operation of BRT, residential rental costs increased between 6.8% and 9.3% for every 5 minutes walking time to BRT stations.
Diaz et al. (2009)	Boston	Silver Line	Development has accelerated along the corridor. Silver Line Phase I has generated at least US $ 93 million in new development, involving a mix of retail, housing and institutional uses.
Diaz et al (2009)	Los Angeles	Orange Line	The transit agency is considering joint development with large multi-unit developers to construct over two million square feet of development at several stations.
Diaz et al (2009)	Las Vegas	MAX	One casino operator has already invested in pedestrian facilities and an additional station.
Diaz et al (2009)	Orlando	LYMMO	The local authority has used the BRT as a tool to promote development. 5 new office buildings with about 1 million square feet per building and 6 new apartment communities have been developed in downtown, possibly resulting from BRT.
Levinson et al (2003ab)	Pittsburgh	East Busway	59 new developments within a 1500-ft radius of station. $302 million in land development benefits, of which $275 million was new construction.
Levinson et al (2003ab)	Ottawa	Transitway	The construction of the Transitway has led to up to U.S. $675 million in new construction around transit stations
Levinson et al (2003ab)	Adelaide	Guided Busway	Tea Tree Gully area is becoming an urban village.
Levinson et al (2003ab)	Brisbane	SouthEast Busway	Property value near BRT stations grew 2 to3 times faster than those located in non-busway suburbs.
DFT (2008)	Kent	Fastrack	The second Fastrack route was fully funded by the developer (ProLogis), as part of the first major mixed-use regeneration project in the Thames Gateway.
Cervero and Kang (2009)	Seoul	BRT	Land use along BRT corridors was intensified. Within 300 metres of BRT stations, residential land values gained premiums ranging from 5% to 10%; within 150 metres of BRT stations, non-residential land values gained premiums varying between 3% and 26%.

Conclusions

- Rapidly worsening traffic congestion has prompted policy-makers to look for environmentally friendly transport modes to mitigate traffic problems.

- For many years rail-based transport systems, such as Metro and LRT, have been the preferred transport improvement options. However, the high capital cost and consequently high operating cost have limited their development in many budget-constrained cities.

- BRT presents a cost-effective and flexible alternative for high-performance transit services, which have increasingly gained interest to policy-makers. In order to improve sustainable mobility with less expenditure, many cities across the world have launched ambitious programmes of BRT system implementation with varying success.

Conclusions

- An appropriately designed BRT system offers a high-quality transport service, comparable to a rail service but at a relatively low cost and short implementation time.
- In common with other forms of Mass Transit, a BRT system has the potential to offer positive impact on land development.
- Bus services are conventionally perceived as slow, polluting, and unreliable by the public, which in turn causes stakeholders to hesitate to consider investing in BRT.
- Understanding the full impacts of BRT is becoming increasingly important, especially as land value uplift conferred by BRT could be part of a strategy contributing to BRT project funds.

Suggested References

- References in these slides may be found in: Deng, T and Nelson, J D (2011) Recent developments in Bus Rapid Transit: A review of the Literature. Transport Reviews, **31**(1), 69-96.

- The National BRT Institute is hosted by the University of South Florida, http://www.nbrti.org/

- Across Latitudes and Cultures - Bus Rapid Transit (ALC-BRT) is a Centre of Excellence for Bus Rapid Transit development implemented in Santiago, Chile, and financed by the Volvo Research and Educational Foundations (VREF), http://www.brt.cl/

- The EC-funded COST Action Buses with a high level of service (TU0603) has been established to better understand sustainable mobility in urban areas and to promote a useful way to enhance the bus image, http://www.bhls.eu/

- For a review of BRT vehicle types: http://citytransport.info/Buses03.htm

Thank you for your attention.

Questions and Comments?

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